Quality Assurance Project Plan (QAPP)

Targeted Stormwater Management Program Effectiveness Monitoring

S8.E

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Prepared by

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Quality Assurance Project Plan

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Distribution List

Copies of the finalized QAPP and subsequent updates to the QAPP will be provided to the project staff identified in Table 1. The project manager and the laboratory manager will be responsible for distributing the QAPP to additional personnel within their organizations that are involved in this program.

Table 1 Distribution List

Name	Title	Organization
John Herrmann	Project Manager	Snohomish County
Steve Britsch	Project Reviewer	Snohomish County
Aaron Young	Laboratory Manager	Am Test Analytical
Rachel McCrea	Ecology Regional Contact	Department of Ecology

Introduction

The Environmental Protection Agency (EPA) developed the National Pollutant Discharge Elimination System (NPDES) Phase I Stormwater program in response to the 1987 Amendments to the Clean Water Act (CWA). The program went into effect in 1990 and focused on municipalities with populations greater than 100,000. The Washington State Department of Ecology developed the NPDES Phase I permits in accordance with the EPA's requirements. These permits were issued to municipalities, including Snohomish County, in 1995.

As required by the permit, the County submitted a Stormwater Management Program to Ecology, which was approved in July 1997. The program required Snohomish County to systematically investigate and identify illicit discharges, investigate specific sites identified as sources of Stormwater pollution and offer technical assistance to remediate the discharges. Snohomish County was re-issued a NPDES Phase I Stormwater permit on January 17, 2007 with an effective date of February 16 2007.

Project Specific NPDES Phase I Requirements

E. Targeted Stormwater Management Program Effectiveness Monitoring

1. *Each Permittee shall conduct monitoring designed to determine the effectiveness of the Permittees SWMP at controlling a stormwater related problem directly addressable by targeted actions in the SWMP. The stormwater management program effectiveness monitoring component shall be designed to answer one of each type of the following questions:*
    a. *The effectiveness of a targeted action (or narrow suite of actions), and*
    b. *The effectiveness of achieving a targeted environmental outcome.*

2. *The monitoring shall at a minimum include stormwater, sediment or receiving water monitoring of physical, chemical and /or biological characteristics. The monitoring may also include data collection and analysis of other programmatic measures of effectiveness such as surveys and polls. Monitoring to identify sub-basin specific water quality problems and characterize discharges for planning purposes may also be included.*

3. *For each of the two questions selected for monitoring, Permittees shall develop a monitoring program containing the following elements:*

    a. *Description of the targeted action/targeted environmental outcome and a explanation of why it is significant to the Permittee, and if the problem is significant to other stormwater managers;*
    b. *Specific hypotheses about the targeted action/targeted environmental outcome that will be tested by the monitoring program;*
    c. *Specific parameters of attributes to be measured; and*
    d. *Expected modifications to management actions depending on the outcome of hypotheses testing.*

Project

Pet Waste Campaign

In 2004 Snohomish County Surface Water Management (SWM) received a Centennial Clean Water Fund grant to institute an animal waste pilot program in conjunction with the Washington State Department of Ecology (Ecology). SMW focused public education and outreach efforts to reduce fecal coliform bacteria from animal waste in streams. A large component of this project was to focus on motivating pet owners to properly pick up and dispose of pet waste. One component of the program focused on a pilot area in an urban, residential neighborhood within the North Creek Watershed immediately south of the City of Mill Creek.

SWM is now preparing to adapt and implement the pet waste program across Urban Growth Areas (UGAs) countywide. This program would involve a social marketing, buzz marketing, and training and supporting veterinary clinics. This campaign is intended to reach approximately 20,000 households per year.

To support this program and meet the NPDES permit requirements identified above SWM will conduct stormwater sampling for fecal coliform in discrete drainage areas targeted by the pet waste program. The sampling program will collect wet weather stormwater samples approximately one and a half years prior to implementation and one and a half years after the pet waste program implementation in the targeted neighborhoods.

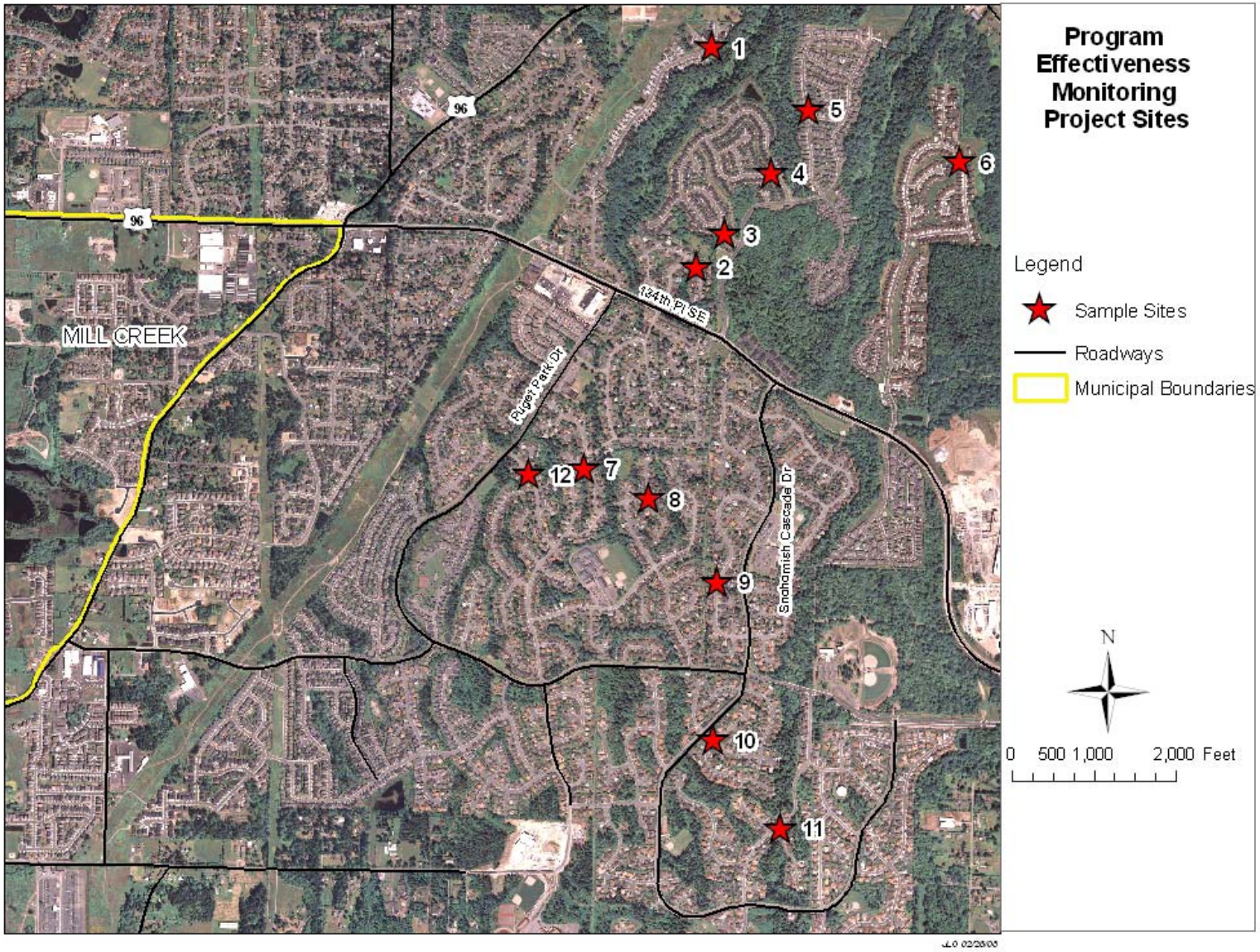
SWM will use automated grab samplers to collect the stormwater sample for 12-15 storm events per year at up to 12 sites. To reduce the variability of the results the first flush of a storm event will not be sampled. SWM will define the first flush event, for the purpose of this study as the first 0.25 inches of rainfall. The geometric mean for the results before the implementation of the pet waste program and after the program implementation will be calculated and compared to identify whether a statistically significant reduction in fecal coliform loading can be identified. The results will then be used to quantify the pet waste program effectiveness.

Study Area

The study area is located east of the City of Mill Creek north and south of 134th Place east of Seattle Hill Road and west of Highway 9. The study sites are located in the Snohomish Basin is listed as an impaired waterbody for primary contact recreation. Ecology has developed a Total Maximum Daily Load (TMDL) for fecal coliform for the Lower Snohomish River Tributaries, which is discussed in more detail in the Detailed Implementation Plan (Ecology 2003).

SWM has identified 12 sampling points within the study area to acquire a statistically significant dataset. The sampling points are located in downstream catch basins of small discrete residential drainage systems within the study area. Figure 1 presents the study area, and the locations of the 12 sampling points within the sample area. Additional, more detailed maps of each site are located in Appendix A.

Figure 1 Snohomish County Monitoring Locations



Background

Animal Waste Management Campaign—Centennial Grant

Runoff of animal waste into lakes, streams, and rivers endangers fish habitat and poses risks to human health. Animal waste consumes oxygen and releases ammonia as it decays in waterbodies, which can kill fish. Animal waste also carries bacteria and parasites and can spread diseases to humans. Because of perceived contributions of animal waste to drainage systems, many streams in Snohomish County do not currently meet state standards for primary contact recreation. Cleanup Plans for North Creek and Snohomish River tributaries identify pet waste handling programs as a high priority water cleanup activity.

Past studies in other areas have found that 30-40% of dog owners do not clean up after walking their dog but that over 60% agree that pet waste contributes to water quality problems. These findings indicate that people may be willing to change their behaviors given the proper tools and motivation. Research conducted by the American Veterinary Medical Association shows that 39.9 percent of Washington State households own dogs, with an average of 1.6 dogs per dog-owning household. It is estimated, based on the 2000 United States Census data that just over 84,000 Snohomish County households own dogs. It was estimated that the Snohomish County dog population is more than 172,000 dogs. At an estimated rate of 0.33 pounds of solid waste produced daily per dog, the estimated daily production of dog waste in Snohomish County is 57,000 pounds per day.

In 2004 Snohomish County Surface Water Management (SWM) received a Centennial Clean Water Fund grant to institute an animal waste pilot program in conjunction with the Washington State Department of Ecology (Ecology). A large component of this project was to focus on motivating pet owners to properly pick up and dispose of pet waste. The program focused on a pilot area in an urban, residential neighborhood within the North Creek Watershed immediately south of the City of Mill Creek. The goals of the social marketing program included:

- Research and pilot programs to reduce stormwater contamination from pet waste.
- Reduce pollution from pet waste in the Snohomish Tributaries, North, Swamp, and Little Bear Creeks.
- Implement pet waste management programs to reduce the sources of fecal contamination in North Creek pursuant to the North Creek TMDL.

As part of this program SWM conducted research with watershed residents to determine the barriers and motivating factors to proper pet waste cleanup and disposal. SWM then applied this research to determine how County staff can best reach watershed residents with information and messages about properly disposing of pet waste and to determine how to motivate and support residents in adopting proper pet waste cleanup and disposal practices.

SWM developed a simple message to center the education campaign around: Scoop the poop, bag it, and place it in the trash. With this message SWM focused on a pilot neighborhood within the North Creek Watershed where research suggested that the residents would be more susceptible to receiving the message. SWM created a campaign based on direct mailings, intensive neighborhood communications, and educating and involving veterinary clinics. Gauged responses from home and pet owners and surveys conducted suggest that this

campaign was successful at getting the message out and motivating behavior change. Final evaluation of the program's success is still underway.

Project Description

Education Campaign

SWM will be adapting and implementing the Snohomish County/Ecology pet waste campaign across the UGAs countywide. In addition, SWM plans to use the pet waste campaign expansion as a pilot to test and evaluate strategies to expand other pilot programs across a larger landscape. The activities planned for this program include:

- Implement the program across the UGA countywide.
- Continue the buzz-marketing strategy developed in the pilot program.
- Adapt the pilot direct mail campaign for landscape-level implementation by directing repeated communications, phased by neighborhood, to approximately 20,000 households per year, with neighborhoods prioritized using psychodemographics, dog population, and water quality data.
- Continue and expand the engagement of veterinary professionals as message vectors though box lunch sessions, distribution of materials through clinics, and support of clinic efforts to disseminate message. Roughly 30 percent of veterinary clinics in Snohomish County have already been reached through the pilot program. SWM plans to contact the remaining clinics and continue support for those already contacted.
- Continue and expand the garbage can sticker program to reinforce neighborhood behavioral norms and foster increased adoption of desired behavior toward the tipping point.

The program will be phased over the county by targeting discrete blocks of 5,000 household units. Approximately four units will be addressed at a time for six months of targeted communication, throughout the year.

Monitoring Program

Surveys

To address permit requirement S8.E.1.a SWM will evaluate the effectiveness of the targeted public outreach within one 5,000 household unit. The public outreach campaign is still in development; therefore the survey monitoring program has yet to be developed. It is expected that the monitoring program will utilize three different survey techniques including readership, physical, and phone surveys. The anticipated feedback SWM could hope to attain is an understanding of behavior change, message penetration, message retention, and message diffusion, as a result of the outreach program.

Readership will surveys gauge the attention recipients pay to publications and mails of the targeted outreach identifying message penetration and retention. Physical surveys observe actual implementation of Best Management Practices (BMPs) by the target audience and will assist in identifying behavior changes, message retention, and message diffusion. Phone surveys will provide data on all of the intended audience responses. The multiple survey techniques are expected to triangulate the responses and actions of the intended audience and provide reliable feedback. SWM is expecting to survey and receive results from a large enough target population to have approximately a 5 percent margin of error.

Additional details of the survey monitoring program will be discussed in the annual report as the program is developed and implemented.

Stormwater Sampling

To support this campaign and meet the NPDES permit requirements S8.E.1.b SWM will conduct stormwater sampling for fecal coliform in discrete drainage areas targeted by the pet waste program. The sampling program will collect wet weather stormwater samples approximately one and a half years prior to implementation and one and a half years after the pet waste program implementation in the targeted neighborhoods.

SWM will use stormwater grab samplers to collect samples for 10-15 storm events per year at 12 sites. To reduce the variability of the results the first flush or approximately the first 0.25 inches of a storm event will not be sampled. This will allow standing water stored in catch basin sumps to be exchanged or well mixed. The seasonal and annual geometric mean for the results before the implementation of the pet waste program and after the program implementation will be calculated and compared to identify if a statistically significant reduction in fecal coliform loading can be identified. The results will then be used to assist in quantifying the pet waste program effectiveness.

The question asked by this study is:

> Is implementing the pet waste campaign in urban neighborhoods effective at reducing fecal coliform bacteria to the urban storm sewer system?

The goals of this study are:

> To detect a 50% difference in the seasonal or annual geometric mean of fecal coliform concentrations in stormwater with 90% confidence based upon outreach efforts conducted after the first year of sampling.

Stormwater sampling will be conducted at twelve selected sampling sites and will be collected using a Nalgene stormwater sampler. The sampler will be installed in catch basins at the bottom of each of the identified, discrete drainage area. Detailed information regarding Nalgene stormwater sampler is provided in Appendix B.

A total of 10-15 stormwater samples from each site will be collected from qualifying storm events throughout the wet and dry seasons to characterize the seasonal and annual geometric mean of fecal coliform in stormwater.

SWM will attempt to collect 60-80 percent of the samples from qualifying storm events during the wet season, while the remaining 20-40 percent of the samples will attempt to be collected during the dry season. Additional details and a definition of a qualifying storm event are provided in the sampling process design.

Information and Data Needs

Snohomish County's 2009 budget will not be finalized until November 2008. A detailed budget for the sampling program will not be able to be provided in the QAPP.

Organization and Schedule

Project Team

The project team is composed of several SWM employees, managing the project, overseeing the quality control process and conducting fieldwork. AmTest Inc. is currently under contract with SWM to provide laboratory services. Additional detail is provided in Table 2.

Table 2 Project Tasks, Staff and Responsibilities

Name	Organization	Phone Number	Responsibility
John Herrmann	Snohomish County SWM	425-388-3464 ext. 4584	Project Management
Steve Britsch	Snohomish County SWM	425-388-3464 ext. 4668	Project Review
Snohomish County Technician TBD	Snohomish County SWM	425-388-3464 ext. 4634	Sample collection
Snohomish County Technician TBD	Snohomish County SWM	425-388-3464 ext. 4570	Sample collection
SWM Intern	Snohomish County SWM	425-388-3464	Sample collection
Aaron Young	AmTest, Inc	425-885-1664	Laboratory Services
Rachel McCrea	Department of Ecology	(425) 649-7223	Ecology Regional Contact

Schedule

An overall project schedule is presented in Appendix C.

Budget and Funding

SWM's 2009 budget will not be finalized until November 2008. An estimated cost of sampling for this program is provided in Table 3.

Table 3 Project Budget

Item	Estimated Cost
2008 Sampling Cost	$31,150
2009 Sampling Cost	$34,200
2010 Sampling Cost	$38,000
2011 Sampling Cost	$41,400
Total	$144,750

Data Quality Objectives

The quality of data collected for a project can be affected by a number of factors. To ensure that the project objectives are met, the quality of the data collected will be measured at each stage of data collection and analysis. Data quality will be assessed by determining the precision and accuracy of the data (Table 4).

Precision

Precision is a measure of how close the computed value is to the same quantity measured several times. Precision will be evaluated using field and laboratory duplicate sample analysis. Field duplicate analyses will indicate the degree of imprecision due to the combined effects of heterogeneity of the stream, variation in sample collection methods, and imprecision of analytical methods. Laboratory duplicate analyses will indicate the degree of imprecision due to the combined effects of sample splitting in the laboratory, and imprecision of analytical methods. Measurement precision will be determined by calculating the RPD expressed as a percent. In general, a precision of 30 percent (Table 4) is considered acceptable for this study.

$$\%RPD = \frac{(S - D)}{(S+D)/2} \times 100\%$$

Where:

%RPD = relative percent difference
S = Analytical result of sample of origin
D = Analytical result of the duplicate sample

Completeness

Completeness is the measure of the amount of valid data needed to be obtained from a measurement. The targeted completeness goal will be 90 percent.

Table 4 Water Measurement Quality Objectives

Parameter	Units	Accuracy (%)	Precision (%RPD)	Required Reporting Limit
Lab Constituents (Water Samples)				
Fecal Coliform Bacteria	Colonies 100ml	NA	30	1 col/100ml

Sampling Process Design

Location

The study boundaries and the sampling points are defined in Figure 1. Detailed maps and information about each sampling site is located in Appendix A.

Stormwater Sampling

Target Population

The target population is the stormwater and the associated contaminants within the stormwater discharged from the outfall shortly after the first flush of each event. The targeted stormwater population is that stormwater runoff that is discharged during a qualifying event, which is defined as the following:

Wet season (October 1 through April 30):

- Rainfall volume: 0.25" minimum, no fixed maximum
- Rainfall duration : No fixed minimum or maximum
- Antecedent dry period: Less than or equal to 0.02" rain in the previous 24 hours
- Inter-event dry period: 6 hours

Dry season (May 1 through September 30):

- Rainfall volume: 0.25" minimum, no fixed maximum
- Rainfall duration: No fixed minimum or maximum
- Antecedent dry period: less than or equal to 0.02" rain in the previous 72 hours
- Inter-event dry period: 6 hours

Monitoring

Samples will be grab samples taken with a Nalgene stormwater sampler, specifications of this sampler are provided in Appendix B. The sampler will be installed in catch basins or manholes at twelve monitoring sites, which receive water from a discrete drainage basin. As water flows onto the sampler the water is directed into the one liter bottle, once the bottle is filled a ball valve shuts the sample bottle off restricting additional water from entering.

The variability of fecal coliform data from the first flush is expected to be high as a result of standing water in the catch basin sumps being flushed out; therefore this water will not be sampled. Previous modeling in other similar basins suggests that approximately the first 0.25 inches of rainfall would flush 70 to 100 percent of the estimated storage volume of the catch basins in the drainage area. This will allow the sample collected to be primarily representative of storm water and fecal coliform running off of the drainage basin.

The water depth during these flushing events was designed to be approximately 0.5-inches. The sampling device will be hung from the catch basin casting with the lip of the sampling device position approximately 0.5-inches above the surface of the sump water in dry weather. Once the water surface elevation rises above 0.5-inches, exceeding the first flush volume, that water will being filling the sampling device. A diagram of this sampling scenario is provided in Appendix B.

Parameters

Fecal coliform will be the only parameter analyzed during this program. Fecal coliform is the parameter targeted for reduction by the pet waste campaign. Other parameters were not considered because they would not provide a link to the reduction of pet waste in the drainage system.

Frequency

A maximum of 10-15 stormwater samples will be collected from qualifying storm events throughout the wet and dry seasons with 60-80 percent of the samples being collected during the wet season and 20-40 percent during the dry. The frequency of collection will be defined by the target population defined previously.

Rainfall Monitoring

An existing Snohomish County automatic rain gauge (Si) will be used to collect 15-minute rainfall at 0.01-inch increments. The flow meter is a High Sierra Electronics Model 2400 tipping bucket attached to a data logger. This data will be used to assist in characterizing the size of the storm event collected.

Sampling Procedures

All water quality sampling will be carried out in accordance with this QAPP. Sampling methods are designed to support water quality monitoring programs while ensuring samples are free of contamination during collection, transport and analysis.

Bottles and Equipment

Fecal coliform sample containers will be supplied by the laboratory contracted to test the samples. The laboratory is responsible for generating an acceptable equipment blank or documentation to demonstrate that the containers are free from trace contamination before they are shipped to SWM.

The Nalgene stormwater samplers will be cleaned prior to the next use. The samplers will be cleaned in the Snohomish County water quality laboratory using the following process (Caltrans 2003):

1. Make up a solution of disinfectant soap in warm tap water.
2. Rinse sampler three times with the solution with a plastic brush
3. Rinse three times with tap water.
4. Soak and rinse in a bleach solution
5. Rinse three times with tap water.
6. Store in a large clean plastic container with a lid.

Decontamination of the equipment will be conducted following a sampling event in preparation for the next event. Each sampler will be labeled with a unique sampler ID number. The sampler ID number, the date of decontamination, and the staff person conducting the decontamination will be recorded and the information stored the project field files. The decontamination form is provided in Appendix D.

Staff will wear clean, powder-free nitrile gloves while decontaminating equipment and while handling clean bottles and equipment.

Stormwater Sampling for Fecal Coliform

Stormwater samples will be collected during working hours at each of the sampling points based on the target population defined previously. Once a storm is identified the laboratory and crew will be notified of the potential schedule. If the storm appears to meet the qualifying storm requirements then the crew will prepare the equipment and monitoring supplies and install the samplers. If the event did not occur, but another event may occur within the next 48 hours then the samplers will be left in place and that event tracked. If an event didn't occur and another is not expected in the next 48-hours or the event did not meet the storm requirements, then the samplers will be picked up and decontaminated. If the event did occur the samples will be picked up and labels will be completed identifying the date, time, sample location, and attached to the bottles at each site. The samples will be placed in a cooler with ice and stored out of direct sunlight for transport, a COC will be completed (Appendix E), and the samples will be delivered to the laboratory. A basic flow chart illustrating the sampling steps is provided in Appendix F. The laboratory will only accept samples up until 3:00 P.M. Monday through Thursday and 12:00 P.M. on Friday. If a sample cannot be collected and delivered to the laboratory on this schedule without exceeding the hold time, then a sample will not be collected for that event.

Field Data Recording

Field data will be collected on the field form presented in Appendix D.

Sample Transport and Chain of Custody

While in the field, samples will be stored and transported in a cooler at the analytes specific temperature requirements as stated in 40 CFR, Part 136. For analysis of fecal coliform in water samples collected in target areas, the contract laboratory needs to receive samples from Monday through Friday morning. A COC will be maintained on all samples transported to the office or laboratory using a form supplied by the laboratory. Each custodian will sign the form when relinquishing or accepting sample custody. Samples will be stored per analyte requirements in coolers under direct observation or in a locked vehicle. The project manager will maintain a file of COC forms.An example copy of a chain of custody form is presented in Appendix E.

Measurement Procedures

The analytical laboratory used in this project to analyze surface water samples is accredited by Ecology for fecal coliform. The analytical methods used by the contract laboratory shall be cited in the laboratory's approved Quality Assurance Plan. The analytical laboratory shall maintain Ecology's accreditation during the contract period with Snohomish County. Table 5 summarizes laboratory procedures for surface water samples for this project.

Table 5 Water Measurement Quality Objectives

Parameter	Number of Samples	Expected Range of Results	Required Reporting Limit	Analytical Method
Fecal Coliform Bacteria	480*	unknown	1 colony/ 100 mL	SM9221E

*Number of samples estimated.

Table 6 Sample Collection and Hold Time Specifications

Parameter	Recommended Quantity	Container	Holding Time	Preservation
Fecal coliform	250 mL	250 mL glass/polypropylene auto claved bottle	24 hours	EDTA

Quality Control

Table 7 outlines quality control procedures for this project.

Field Duplicate Samples

A minimum of one field duplicate water sample will be collected for every ten field samples collected for each analytical parameter. The duplicate pairs shall consist of two full volume samples, one collected immediately after the other. These samples will be labeled in such a manner that the laboratory will not know that the samples are replicates. The field duplicate analyses will be used to determine whether experimental precision is adequate.

Field Blanks

A minimum of one field blank water sample will be collected for every twenty field samples collected for each analytical parameter. The blank will be collected in the field by filling the sample bottle with de-ionized water. These samples will be labeled as a blank and used to identify cross-contamination in the sampling procedures or existent in the sample bottles.

Laboratory Quality Control Documentation

The laboratory will provide, upon request, all supporting microbiological documentation supporting the analysis of samples in accordance with Standard Method 9221E.

Table 7 Quality Control Procedures

Field		
Parameter	**Blanks**	**Duplicates**
Fecal Coliform	1/20 Samples	1/10 Samples

Corrective Action

Corrective action will be taken by SWM whenever a deficiency in a sample result or analytical report is noted. It is the responsibility of the project manager to see that appropriate corrective action is taken. In the event a field measurement is not recorded or is missed entirely, the project manager will evaluate factors such as changing water levels, accessibility of the site, and the length of time since the last sampling when deciding the appropriate corrective action. Re-measuring a missed field measurement after the sampling round is complete will occur at the project manager's discretion. In the event field equipment fails or returns unusable data, corrective action will be taken as described above. Even the best-packed sample containers are sometimes lost or broken during transport. Missing or damaged samples will be handled according to the procedure outlined above.

The project manager will contact the analytical laboratory if any data or quality control information is not included in the laboratory data package. The project manager will direct the analytical laboratory to analyze any unused portion of the missing sample. In the event that no portion of the sample is available, the situation will be treated as a missing or damaged sample.

Missed holding times will be handled according to the procedure outlined above. The project manager may also elect not to use the data from a sample that has exceeded its holding time or to use that data but attach appropriate data qualifiers.

Data Management Procedures

Data packages from a completed set of samples will be sent to SWM by the laboratory within 30 days of the sampling date. Data reports from the analytical laboratory will be reviewed for completeness by the project manager. Potential errors and omissions will be reported to the responsible laboratory personnel. Acceptable laboratory reports will be stored in project notebooks. Laboratory results will be entered into a database and verified. Based on the distributions and statistical characteristics of the data, various statistical and probabilistic methods may be used to compare and analyze the data. The statistical methodologies and assumptions used in the assessment of water quality data will be discussed in the annual and final project reports.

The analytical reports will be compared to the COC by the project manager or designee to ensure that all requested analyses have been performed. Errors or missing data will be reported to the responsible laboratory personnel immediately. Amended and corrected analytical reports will be attached to the report being corrected to ensure that only the corrected data are reported in the database and used in the data analysis.

An analytical laboratory data report will be reviewed for completeness by the project manager or designee. Each laboratory report will contain the following information:

- Project name, project manager's name
- Sample date, date of sample receipt
- Signature of laboratory representative
- Description of each sample
- Laboratory sample number
- Analyte
- Date prepared, date of analysis
- Laboratory method, reporting limit
- Result, unit

Data will be accepted without qualifiers if the analytical reports meet the quality assurance guidelines detailed in this QAPP. Before qualifiers are attached to any data, the project manager will make every effort to correct the data by reviewing the sample documentation, meeting with Snohomish County SWM staff, and contacting the analytical laboratory. Appropriate qualifiers will be attached to any data that do not meet the QAPP standards. All data will be reported, regardless of the qualifiers attached; however, the Project manager may elect not to include qualified data in the water quality data analysis.

Audits and Reports

Audits

A technical systems audit will be conducted three months following the initiation of the monitoring program. The audit will review the staff conformance to the QAPP procedures. If project implementation is not in conformance to the QAPP, corrective procedures will be taken as soon as possible. If the audit identifies a deficiency or a required change in the QAPP, that change will be made and submitted to the Department of Ecology as soon as possible. The audit will be conducted by the project reviewer identified in Table 2.

Reports

Snohomish County will produce project reports according to its NPDES Phase I permit. The permit requires under S8.H:

> 1) *The stormwater monitoring report shall be submitted with the annual report each year, beginning in 2009 for independent monitoring and 2010 for collaborative monitoring. Each report shall include all monitoring data collected during the preceding period from October 1 through September 30. Each report shall also integrate data from earlier years into the analysis of results, as appropriate. Permittees that choose to participate in an integrated water quality monitoring program shall submit a single integrated monitoring report. Reports shall be submitted in both paper and electronic form and shall include:*
>
> b) *Stormwater Management Program Effectiveness Monitoring Reporting*
>
> i) *A summary of the purpose, design, and methods of the monitoring program,*
>
> ii) *The status of implementing the monitoring program.*
>
> iii) *A comprehensive data and QA/QC report for each part of the monitoring program, with an explanation and discussion of the results of each monitoring project,*
>
> iv) *An analysis of the results of each part of the monitoring program, including any identified water quality problems or improvements or other trends in stormwater or receiving water quality, and*
>
> v) *Recommended future actions based on the findings.*

Data Verification

Data verification will be conducted by reviewing the field data inputs, and the completed COC. Additional information including all supporting microbiological documentation may be reviewed if poor data quality trends or significant problems are identified. The data verification process will be conducted by the project manager. The data verification procedures will use the flow chart modified from Caltrans (2003) presented in Appendix F as a guide.

Any changes to the results as originally reported by the laboratory should either be accompanied by a note of explanation from the data verifier or the laboratory, or reflected in a revised laboratory data report.

Data verification records include certification statements that certify the data have been verified and signed by appropriate personnel. Data verification records can also include a narrative that identifies technical non-compliance issues or shortcomings of the data produced during the field or laboratory activities.

Data Validation (Usability) Assessment

Data validation and usability assessments will be conducted bi-annually following the conclusion of each wet and dry season. A data validation report will be completed documenting the process and results. This report will be filed in the project files. The data verification process will be conducted by project manager in Table 2.

Preliminary Data Review

Initial data validation or usability assessments will focus on reviewing the data verification records, laboratory reports, field reports and COCs. This review will look at qualified or flagged data previously identified and evaluate its impact to the overall data quality objectives. If the data does not meet the statistical data review criteria, then the data point will be removed from the overall dataset. The preliminary review may incorporate statistical review methods described later in this section. Data issues that may threaten the usability of the data may include: apparent anomalies in recorded data, missing values, deviations from standard operating procedures, and the use of nonstandard data collection methodologies (EPA 2000).

Statistical Data Review

A statistical data review will be conducted to identify outliers and other abnormalities in the data. Statistical analysis will calculate the mean, median, mode, sample range, sample variance, and standard deviation. A list of statistical equation is provided in Figure 2. Outliers or data that is anomalous with the entire data set will be reviewed for the origin of the error in data collection, laboratory analysis, data input and recording, QA/QC, and data verification. If the data is unable to conform, does not meet the data quality objectives or it is uncertain if the data is able to conform with the project data set and goals then the data will be removed.

Figure 2 Statistical Equations

Box 2-4: Directions for Calculating the Measures of Dispersion

Let $X_1, X_2, \ldots, X_n$ represent the n data points.

Sample Range: The sample range (R) is the difference between the largest value and the smallest value of the sample, i.e., R = maximum - minimum.

Sample Variance: To compute the sample variance (s^2), compute:

$$s^2 = \frac{\sum_{i=1}^{n} X_i^2 - \frac{1}{n}\left(\sum_{i=1}^{n} X_i\right)^2}{n-1}$$

Sample Standard Deviation: The sample standard deviation (s) is the square root of the sample variance, i.e.,

$$s = \sqrt{s^2}$$

Coefficient of Variation: The coefficient of variation (CV) is the standard deviation divided by the sample mean (Section 2.2.2), i.e., CV = s/ $\bar{x}$. The CV is often expressed as a percentage.

Interquartile Range: Use the directions in Section 2.2.1 to compute the 25th and 75th percentiles of the data (y(25) and y(75) respectively). The interquartile range (IQR) is the difference between these values, i.e.,
IQR = y(75) - y(25).

EPA 2000

Graphical Review

The data will be plotted using a scatter plot to identify additional outliers or confirm outliers and abnormal data. Outlying data will be compared against the statistical and the preliminary data review to confirm that the point is an outlier or anomaly.

Non-Detects

Non-detected data will not be addressed through deletion or substitution, but will be statistically incorporated into the data set by using commercially available software. The method and software have not been identified as of the data of this QAPP.

Data Analysis

The data will be compiled from the 12 sites and a seasonal and annual geo-mean will be calculated to evaluate the pre and post fecal coliform levels.

References

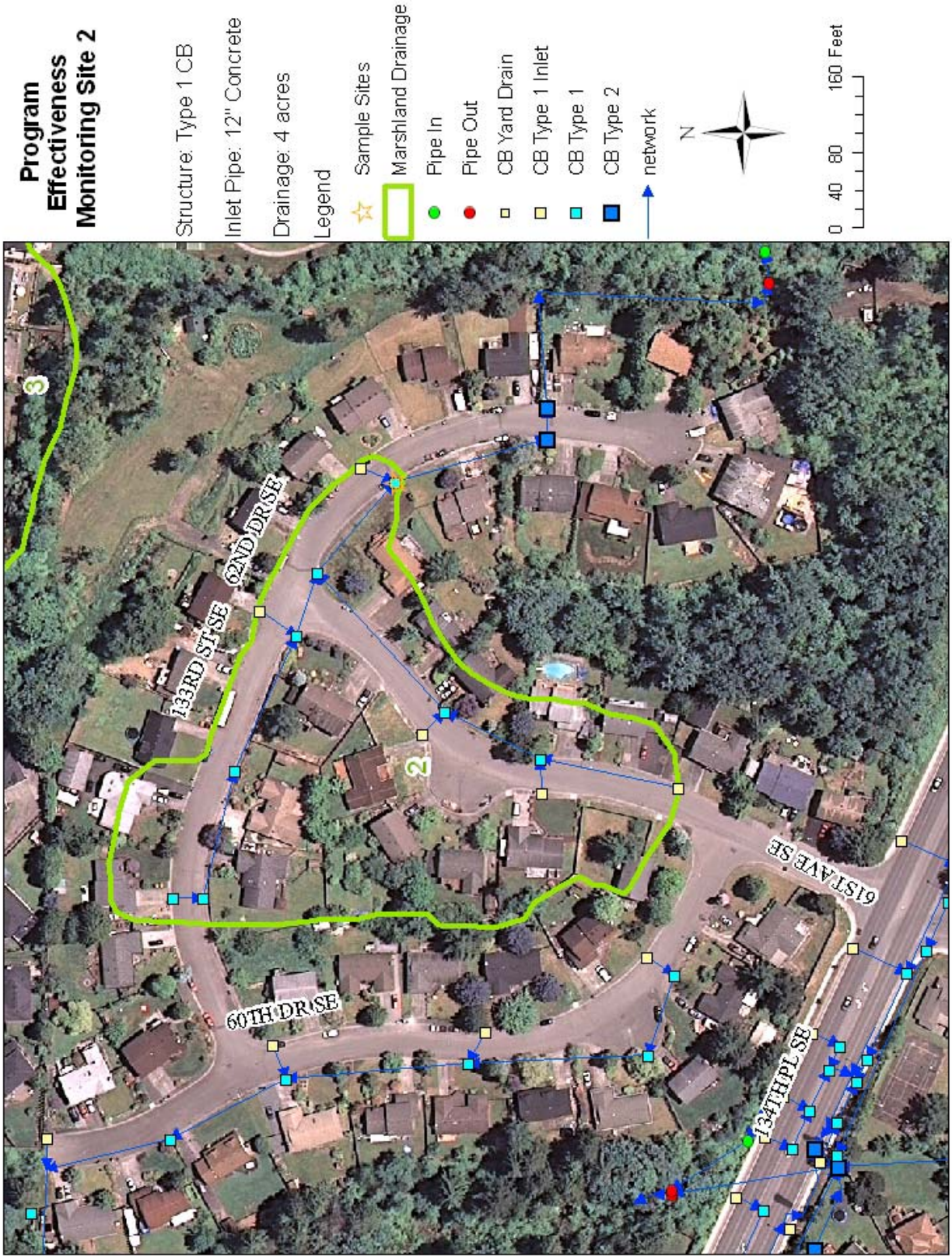
California Department of Transportation (Caltrans). 2003. Caltrans Comprehensive Protocols Guidance Manual. Sacramento, CA. Publication No. CTSW-RT-03-105.51.42

Department of Ecology (Ecology). 2003. Lower Snohomish River Tributaries Fecal Coliform Bacteria Total Maximum Daily Load Detailed Implementation Plan. Bellevue, WA. Publication No. 03-10-031.

Lombard, S.M., and Kirchmer, C.J. 2001. Guidelines for preparing quality assurance project plans for environmental studies: Washington Department of Ecology Publication No. 01-03-003, 37 pp. Olympia, WA.

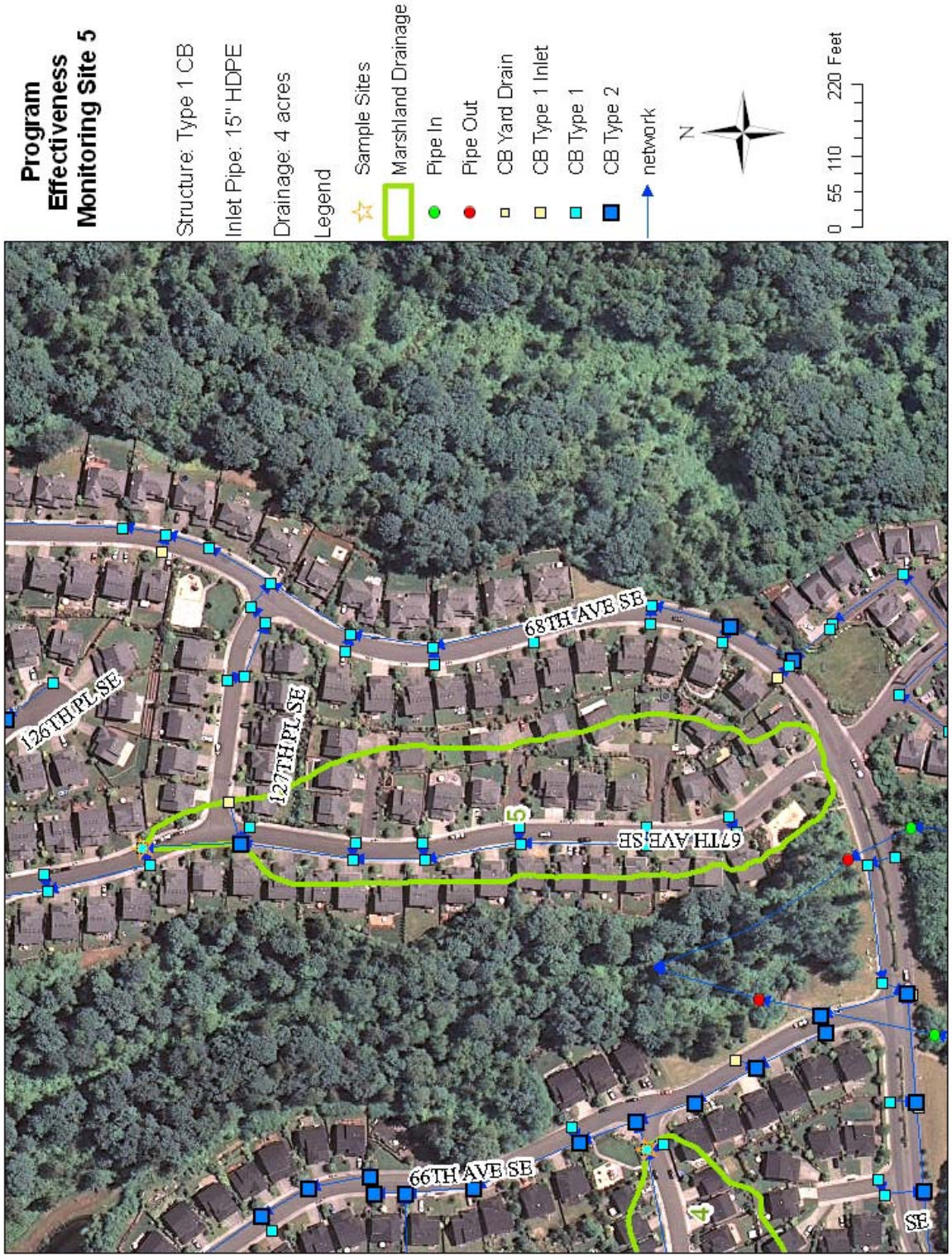
Appendix A Monitoring Location Information

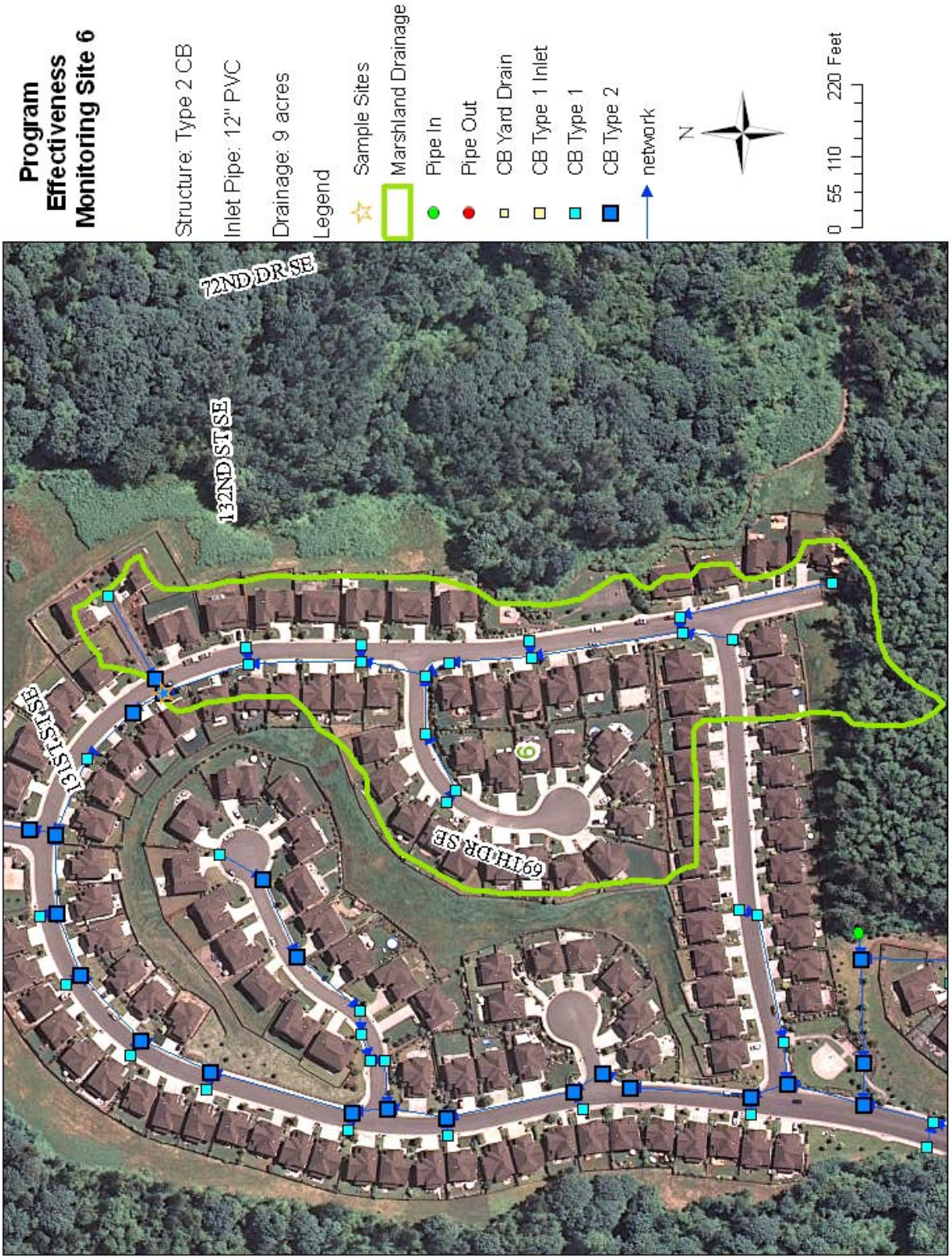
Program
Effectiveness
Monitoring Site 1
Structure: Type 1 CB
Inlet Pipe: 15" PVC
Drainage: 4 acres
Legend
Sample Sites
Marshland Drainage
Pipe In
Pipe Out
CB Yard Drain
CB Type 1 Inlet
CB Type 1
CB Type 2
network
N
0 55 110 220 Feet
12TH ST SE
SMITHGR SE
1

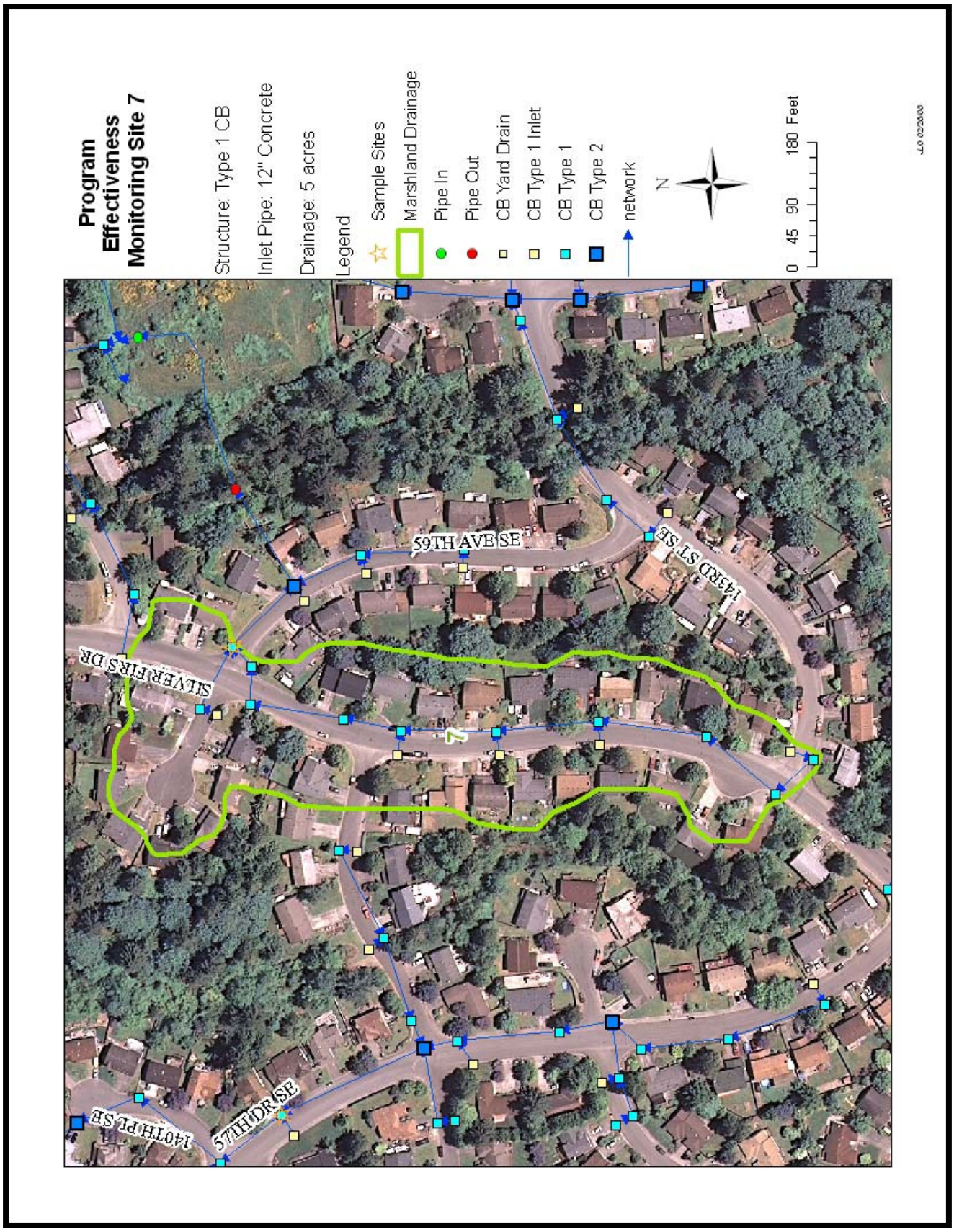

Program
Effectiveness
Monitoring Site 2
Structure: Type 1 CB
Inlet Pipe: 12" Concrete
Drainage: 4 acres
Legend
Sample Sites
Marshland Drainage
Pipe In
Pipe Out
CB Yard Drain
CB Type 1 Inlet
CB Type 1
CB Type 2
network
N
0 40 80 160 Feet
133RD ST SE
62ND DR SE
60TH DR SE
61ST AVE SE
134TH PL SE
2
3

Program
Effectiveness
Monitoring Site 3
Structure: Type 1 CB
Inlet Pipe: 15" HDPE
Drainage: 6 acres
Legend
Sample Sites
Marshland Drainage
Pipe In
Pipe Out
CB Yard Drain
CB Type 1 Inlet
CB Type 1
CB Type 2
network
N
0 40 80 160 Feet
130TH ST SE
64TH AVE SE
4
3
63RD DR SE
N SNOHOMISH CASCADE DR
63RD AVE SE
130TH PL SE
133RD ST SE
62ND DR SE
2

Program
Effectiveness
Monitoring Site 4
Structure: Type 1 CB
Inlet Pipe: 12" HDPE
Drainage: 7 acres
Legend
Sample Sites
Marshland Drainage
Pipe In
Pipe Out
CB Yard Drain
CB Type 1 Inlet
CB Type 1
CB Type 2
network
N
0 40 80 160 Feet
66TH AVE SE
130TH ST SE
64TH DR SE
129TH ST SE
128TH PL SE
64TH AVE SE
129TH PL SE
63RD DR SE
4
3


Program
Effectiveness
Monitoring Site 5
Structure: Type 1 CB
Inlet Pipe: 15" HDPE
Drainage: 4 acres
Legend
Sample Sites
Marshland Drainage
Pipe In
Pipe Out
CB Yard Drain
CB Type 1 Inlet
CB Type 1
CB Type 2
network
N
0 55 110 220 Feet
126TH PL SE
127TH PL SE
68TH AVE SE
67TH AVE SE
66TH AVE SE
5
4


Program
Effectiveness
Monitoring Site 6
Structure: Type 2 CB
Inlet Pipe: 12" PVC
Drainage: 9 acres
Legend
Sample Sites
Marshland Drainage
Pipe In
Pipe Out
CB Yard Drain
CB Type 1 Inlet
CB Type 1
CB Type 2
network
N
0 55 110 220 Feet
72ND DR SE
132ND ST SE
13ISTISE
69THDR SE
6


Program
Effectiveness
Monitoring Site 7
Structure: Type 1 CB
Inlet Pipe: 12" Concrete
Drainage: 5 acres
Legend
Sample Sites
Marshland Drainage
Pipe In
Pipe Out
CB Yard Drain
CB Type 1 Inlet
CB Type 1
CB Type 2
network
N
0 45 90 180 Feet
59TH AVE SE
SILVER FIR'S DR
140TH PL SE
57TH DR SE
143RD ST SE
7

Program
Effectiveness
Monitoring Site 8
Structure: Type 1 CB
Inlet Pipe: 12" Concrete
Drainage: 10 acres
Legend
Sample Sites
Marshland Drainage
Pipe In
Pipe Out
CB Yard Drain
CB Type 1 Inlet
CB Type 1
CB Type 2
network
N
0 35 70 140 Feet
61ST AVE SE
142ND ST SE
142ND PL SE
62ND DR SE
63RD DR SE
60TH AVE SE
141TH ST SE
8

Program
Effectiveness
Monitoring Site 9
Structure: Type 2 CB
Inlet Pipe: 18" CMP
Drainage: 5 acres
Legend
Sample Sites
Marshland Drainage
Pipe In
Pipe Out
CB Yard Drain
CB Type 1 Inlet
CB Type 1
CB Type 2
network
N
0 45 90 180 Feet
145TH ST SE
146TH ST SE
SNOHOMISH CASCADE DR
SNOHOMISH CASCADE DR
146TH PL SE
64TH AVE SE
145TH PL SE
63RD DR SE
9
146TH PL SE
62ND DR SE
PUGET PARK DR

Program
Effectiveness
Monitoring Site 10
Structure: Type 1 CB
Inlet Pipe: 12" HDPE
Drainage: 5 acres
Legend
Sample Sites
Marshland Drainage
Pipe In
Pipe Out
CB Yard Drain
CB Type 1 Inlet
CB Type 1
CB Type 2
network
N
0 35 70 140 Feet
10
65TH AVE SE
65RD DR SE
151ST ST SE
152ND ST SE
SNOHOMISH CASCADE DR
149TH ST SE
63RD AVE SE

Program
Effectiveness
Monitoring Site 11
Structure: Type 2 CB
Inlet Pipe: 12" HDPE
Drainage: 3 acres
Legend
Sample Sites
Marshland Drainage
Pipe In
Pipe Out
CB Yard Drain
CB Type 1 Inlet
CB Type 1
CB Type 2
network
N
0 40 80 160 Feet
154TH PL SE
67TH DR SE
156TH ST SE
66TH AVE SE
11
67TH AVE SE
154TH ST SE
65TH AVE SE
156TH ST SE

Program
Effectiveness
Monitoring Site 12
Structure: Type 1 CB
Inlet Pipe: 15" Concrete
Drainage: 12 acres
Legend
Sample Sites
Marshland Drainage
Pipe In
Pipe Out
CB Yard Drain
CB Type 1 Inlet
CB Type 1
CB Type 2
network
N
0 45 90 180 Feet
7
12
57TH DR SE
141ST PL SE
142ND PL SE
143RD ST SE
144TH ST SE
145ND ST SE
SILVERTIPS DR
55TH AVE SE

Appendix B Sampler Specifications and Monitoring Modifications

Storm Water Sampler
by NALGENE®

Ordering Information – Storm Water Sampler/Kit

Cat. No.	Description	Qty / cs	Nominal Volume	Height Inches (mm)	Outside Dia., in. (mm)	Suggested List Price / cs	Suggested List Price / ea.
1100-1000	Storm Water Sampler, single use, HDPE	4	1L	13.2 (33.5)	3.8 (9.5)	$140.00	$35.00
NEW 1120-1000	Storm Water Sampler, single use, Glass	4	1L	13.2 (33.5)	3.8 (9.5)	$160.00	$40.00
1160-1000	Mounting kit, reusable	1	N/A	15.6 (39.7)	4.6 (11.7)	$40.00	$40.00

How to Order Storm Water Sampler or Mounting Kit

NALGENE® Brand Products are available through NALGENE authorized distributors, or online at www.Stormwatersampler.com.

Prices, product appearance and specifications are current at the time of printing, subject to change without notice. Availability for certain products may be limited by federal, state, provincial or local licensing requirements. All prices are in US dollars unless otherwise noted.

NALGENE®

75 Panorama Creek Drive
Rochester, NY 14625-2385 U.S.A.
www.Stormwatersampler.com

U.S.A. and Canada
Tel: 1-800-625-4327
Fax: 1-800-625-4363
E-mail:
Technical.nalgene@thermofisher.com

Europe (U.K.):
Tel: +44 (0) 1432 263933
Fax: +44 (0) 1432 376567
E-mail: sales@nalgene.co.uk

Japan:
Tel: +81 3 3816 3355
Fax: +81 3 3816 6799
E-mail: info@nalgenunc.co.jp

Other Countries
(U.S.A., International Dept.)
Tel: +1 585 899 7198
Fax:+1 585 899 7195
E-mail:intlmktgthermofisher@nalgenunc.com

FM 31464
ISO 13485 Certified

L16235 © 2007 Thermo Fisher Scientific
NNI-MP 0107-5000 Printed in U.S.A.

Storm Water Sampler
by NALGENE®

First flush grab sampling for organics or inorganics

- Unattended First Flush Grab Sample Collection
- Economical and EPA Compliant
- Easy and Convenient
- Ditch, storm grate or stream mounting
- Improved mounting tube design collects only the runoff, not the rain (ditch & stream)

Patent Pending

Storm Water Sampler by NALGENE®

The NALGENE Storm Water Sampler is a convenient and affordable device for collecting quarterly storm water grab samples in compliance with EPA sampling requirements. The Storm Water Sampler can collect a full one liter grab sample of first flush storm water through a storm water ditch, stream or storm grate outfall. Position the sampler in its protective mounting tube at a convenient time prior to a rain event, and leave it in place until after the storm. The sampler automatically collects the sample into a NALGENE plastic or glass sample bottle, shutting off after the bottle is full to prevent dilution with later runoff. The sample can be conveniently retrieved after the storm. No more standing in the rain waiting for water to flow, or missing sampling events.

Affordable

Compare with other mechanical or automated samplers. The NALGENE Storm Water Sampler is affordable enough to sample multiple outfalls in one rain event. The lowest cost EPA compliant alternative starts at over $350.00.

Satisfies EPA Sampling Requirements

The NALGENE Storm Water Sampler collects a full liter of sample within the first 30 minutes of a qualifying rain event. The sampling mechanism closes after sample collection to prevent co-mingling with later run-off or volatile analyte loss. Use the HDPE Sampler unit for inorganic and visual analysis. Choose the amber glass bottle with fluorinated collection unit for organic analyses such as oil and grease. The redesigned mounting tube collects only the run-off, not the rain, when mounted in ditch or stream outfalls.

Easy to Use

Position the reusable Mounting Kit once, then just re-load with samplers. No programming or complicated trip-switch mechanisms. Water simply flows through the sampler's collection funnel, and directly into a NALGENE HDPE or glass sample bottle. When the bottle is full, a floating ball valve seals off the sample collection port.

When the sample is retrieved, the collection funnel is discarded and replaced with a standard closure for leakproof lab transport. Suspended solids are either collected in the bottle or trapped by the mounting tube's collection screen for visual evaluation.

Prevents Cross Contamination

The sampling device is disposable. Use it once, and throw it away! No decontamination required. No chance of cross-contamination between samples. The reusable mounting tube can be dedicated to a single outfall.

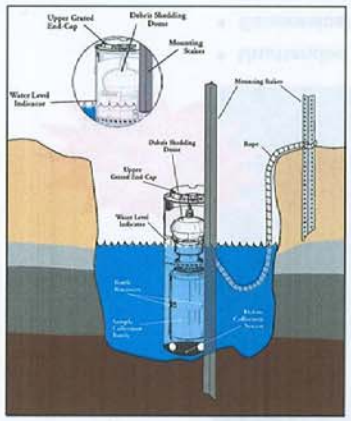
Convenient

The storm water sampler can be positioned in a storm water outfall prior to a qualifying rain event, and retrieved at a convenient time after the storm. No need to rush to remote sampling locations trying to catch the first 30 minutes of flow.

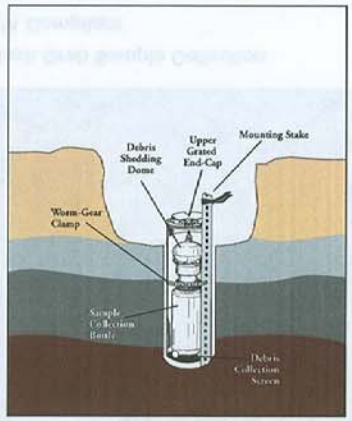
Versatile

The Storm Water Sampler can be mounted in a variety of outfall types including storm grates, ditches and streams. Positioning instructions are included with each sampler and mounting kit.

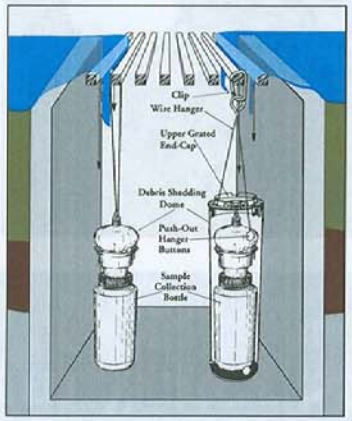
Storm Water Sampler Mounting Kit



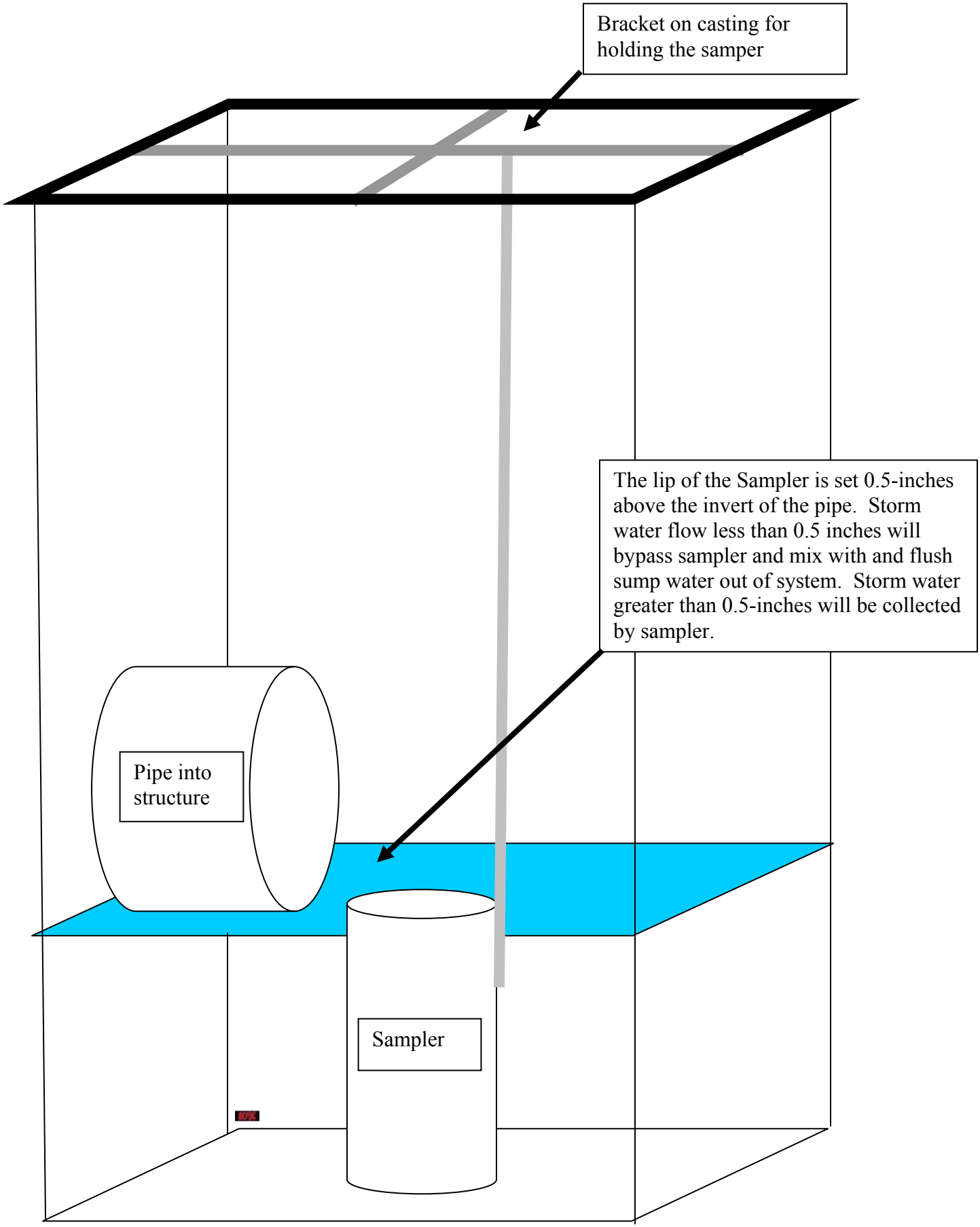
Stream Mount



Ditch Mount



Grate Mount

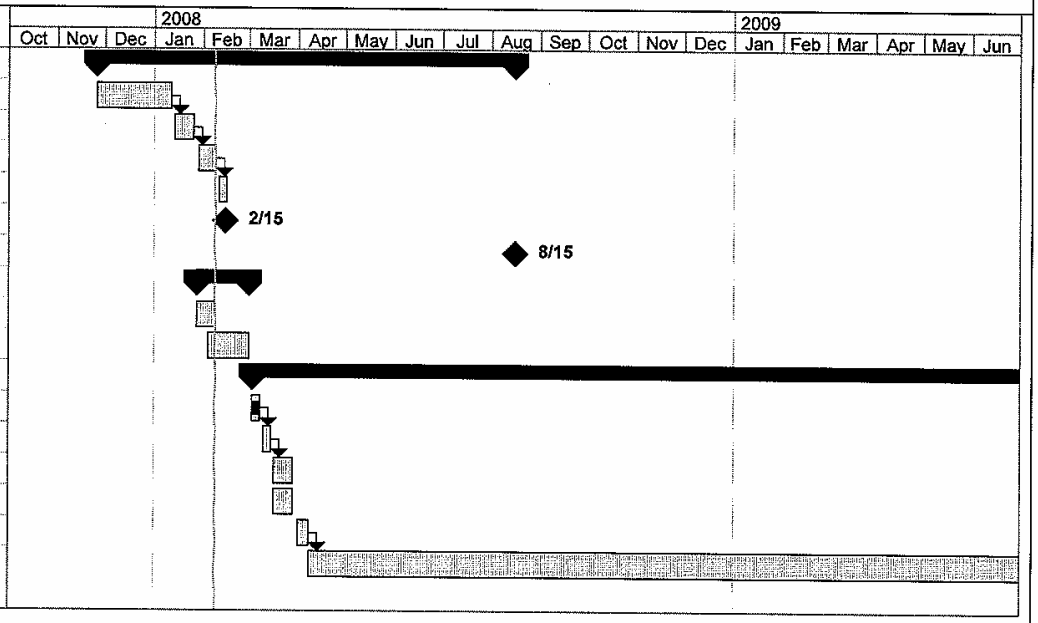


Typical sampler set up in a catch basin

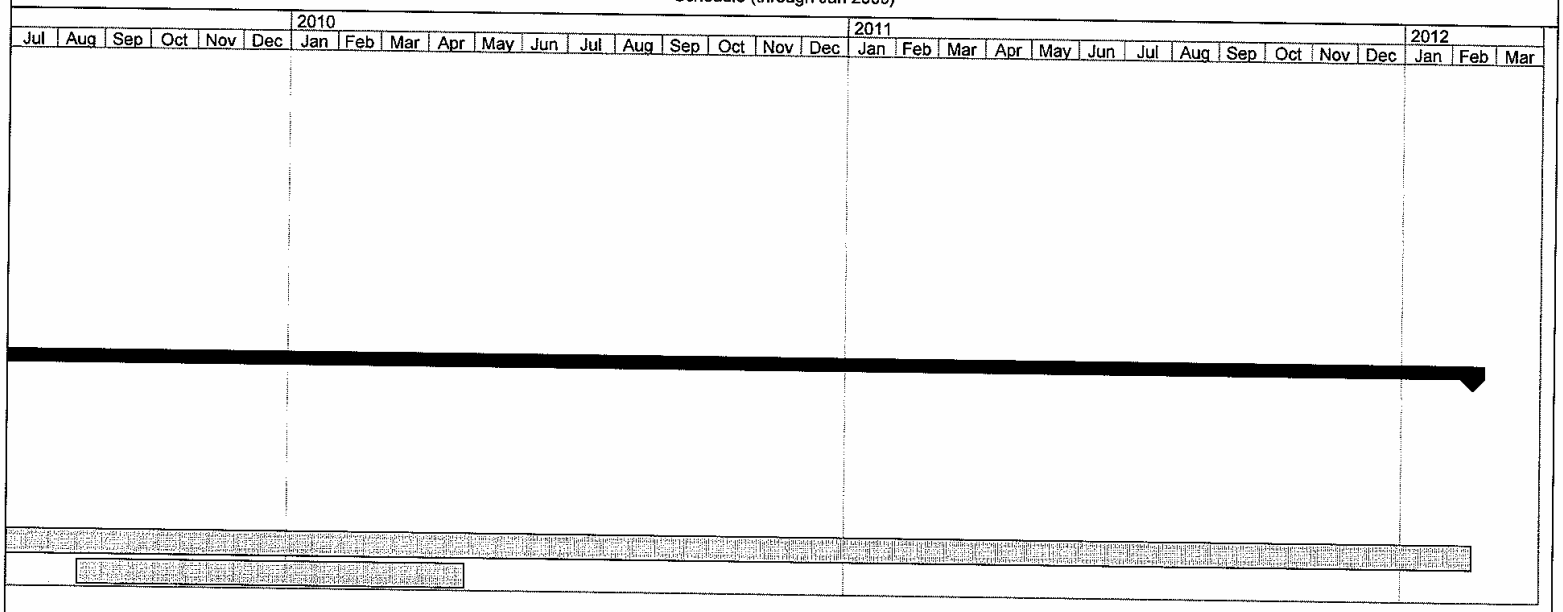
Appendix C Schedules

S8.E Targeted Stormwater Management Program Effectiveness Monitoring
Schedule (through Jan 2009)

ID	Task Name
1	**QAPP**
2	Draft QAPP
3	Review Draft QAPP
4	Address Review Comments
5	Submit QAPP to Ecology
6	Drop Dead Sumbit Date
7	Finalized QAPP Due
8	**Identify Target Areas**
9	Conduct GIS Analysis to Identify Basins
10	Identify Sampling Points in Project Basin
11	**Sampling**
12	Construct Test Stormwater Sampler
13	Test Sampler for Functionality
14	Collect Test Samples
15	Conduct Rinsate Blank of decontaminated bottle
16	Install Remaining Samplers
17	Stormwater Sampling
18	Targeted Outreach and Education



S8.E Targeted Stormwater Management Program Effectiveness Monitoring
Schedule (through Jan 2009)



Appendix D Forms

PROGRAM EFFECTIVENESS MONITORING
FIELD FORM

LOCATION:_____ FIELD STAFF:_____

WET SEASON (October-April) ☐ DRY SEASON (May-September) ☐

ANTECEEDANT CONDITIONS MET? YES ☐ NO ☐

SAMPLER DEPLOYMENT

DATE:_____ TIME:_____

CB CONDITION: GOOD ☐ SILTED ☐ DAMAGED ☐ NEEDS CLEANING ☐

SAMPLER CONDITION: GOOD ☐ DAMAGED ☐

COMMENTS:_____

SAMPLE COLLECTION

DATE:_____ TIME:_____

APPROX PRECIPITATION_____INCHES
(to the nearest tenth, gathered from www.wunderground.com)

SAMPLE COLLECTED: YES ☐ NO ☐

SAMPLE TYPE: SAMPLE ☐ DUPLICATE ☐ BLANK ☐
(check all that apply)

COMMENTS:_____

X:\Wq\NPDES\Monitoring S.8\Program Effectiveness Monitoring\Project Management\PEM field form updated.doc

Decontamination Record Form

Date: _____ Project: _____

Staff: _____

Equipment Type	Equipment Number

Was and Equipment Blank Taken? Yes No

Equipment Type	Equipment Number	Result

Is a follow up blank required? Yes No

AMTEST LABORATORIES
Professional Analytical Services

AmTest Chain of Custody Record

14603 NE 87th St. Redmond, WA 98052
Ph (425) 885-1664 Fx (425) 883-3495
www.amtestlab.com

Page_____ of_____

Chain of Custody No._____

Client Name & Address:	Invoice To:
Contact Person:	Invoice Contact:
Phone No:	PO Number:
Fax No:	Invoice Ph/Fax:
E-mail:	Invoice E-mail:
Report Delivery: (Choose all that apply) Mail / Fax / Email / Posted Online	Data posted to online account: YES / NO Web Login ID:

Special Instructions:

Requested TAT: (Rush must be pre-approved by lab)
Standard RUSH (5 Day / 3 Day / 48 HR / 24 HR)

RUSH Request Approved By:

Project Name:

Project Number:

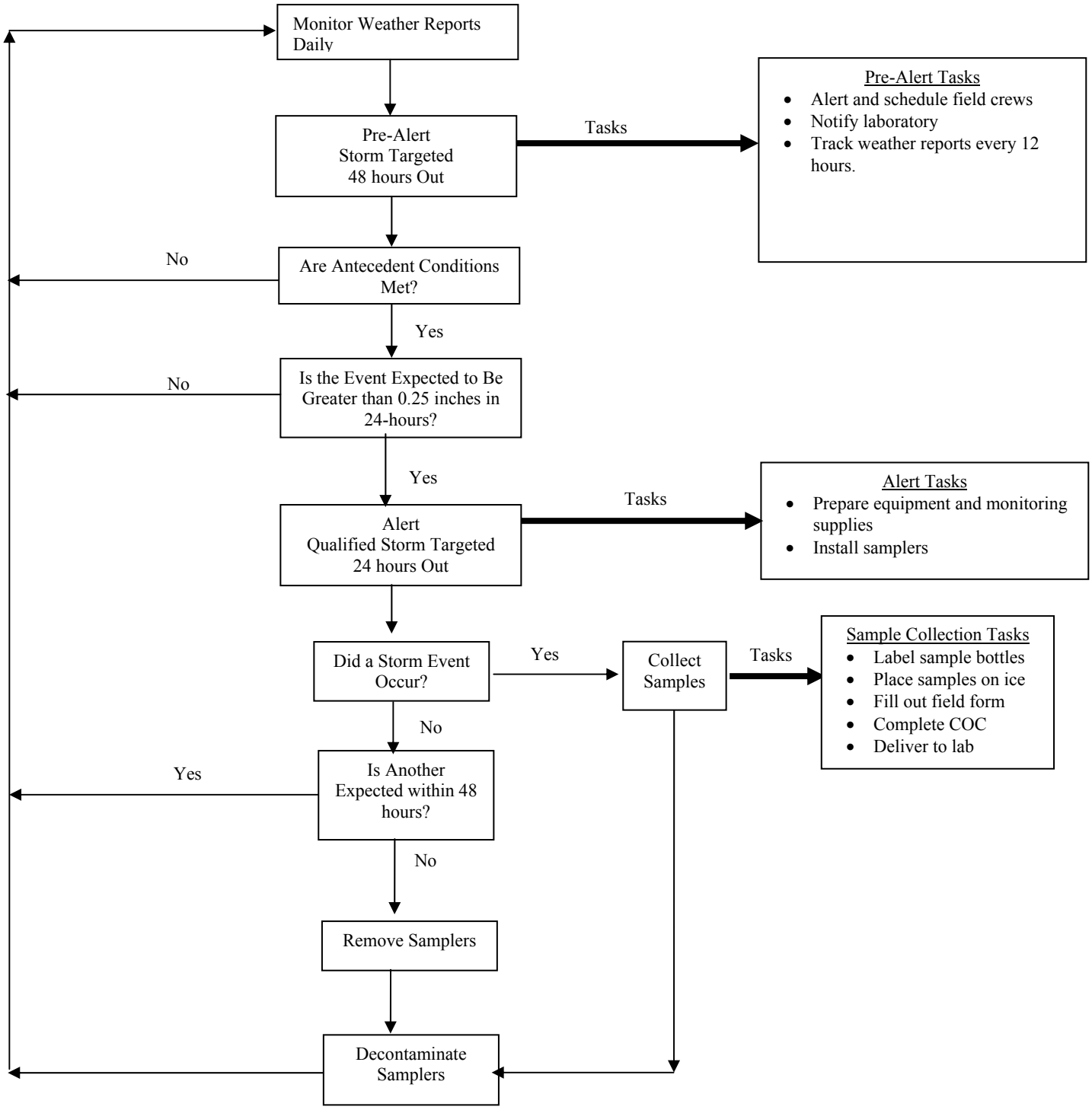
AmTest ID	Client ID (35 characters max)	Date Sampled	Time Sampled	Matrix	No. of containers	Analysis Requested									

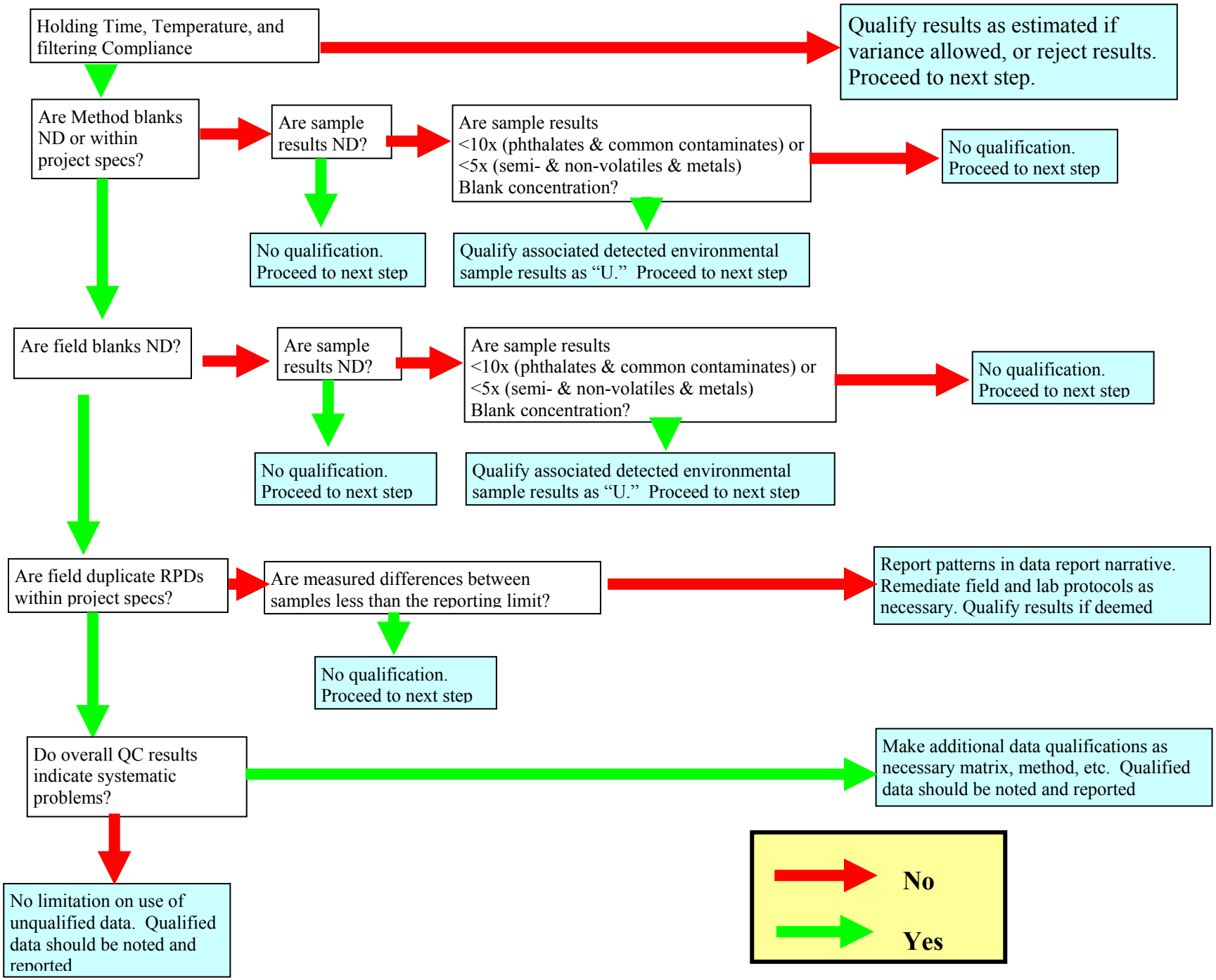
Collected/Relinquished By:	Date	Time	Received By:	Date	Time
Relinquished By:	Date	Time	Received By:	Date	Time
Relinquished By:	Date	Time	Received By:	Date	Time

COMMENTS:

Appendix E Monitoring Flow Chart

Monitoring Flow Chart



Appendix F Monitoring Flow Chart

Technical Data Evaluation QA/QC Samples